A NATIONAL COASTAL MONITORING PROGRAM
COLLECTING AND DISSEMINATING INFORMATION FOR ENVIRONMENTAL DECISION-MAKING

INTRODUCTION

The need for coastal monitoring has never been more evident. The growing risk to natural resources and the impediments to ensuring safe and efficient maritime commerce converge on a clear and demonstrable need for more and better information on conditions within the coastal regime. Examples of those resources at risk and the threats to coastal navigation are outlined in Section I.

Section II summarizes important recent and ongoing studies from government, academia, industry, and the environmental community that outline both the need for, and the specifics of, coastal monitoring. This proposed effort is responsive to both the needs and approaches identified in those reports.

Section III outlines a proposed 3-tiered approach based on a framework developed by the Committee on Environment and Natural Resources. The three tiers provide the format for integration across time- and space-scales that is needed to address multiple issues for multiple constituents.

Section IV provides an implementation strategy that builds upon and integrates existing programs and fills critical gaps in the 3-tiered strategy. Section V recommends a coordination structure to ensure full interagency cooperation and appropriate input and advice from both user and scientific communities and Section VI provides estimates of new resources needed to implement this important effort to:

> ***... provide a national capability to measure, understand, analyze, and forecast natural and human-induced environmental change that effects coastal economies, public safety, and the sustained production of ecological goods and services.***

I. Coastal Risks and Opportunities

It has become clear that the health and wealth of the United States depends significantly on its ability to use and conserve the resources of its coastal region. This region -- including the watersheds and communities that ring the Great Lakes and ocean shores, the shores themselves, and the waters and ecosystems of its bays, estuaries, Great Lakes, and coastal ocean:

... is home for over half the U.S. population; three-fourths by 2010;
... supports 28.3 million jobs;
... generates over $54B in goods and services; that's over 1/3 of the U.S. GDP;
... supports about 180 million recreational visitors each year;
... is 70% larger than the land area of the U.S. and larger than any other nation's EEZ

Key habitats for breeding and wintering migratory birds (shorebirds, colonial nesting birds, waterfowl, etc.) are found in coastal areas, coastal ecosystems serve as key spawning, nursery, and foraging habitat for many fish, shellfish, and avian species, and some of the most visited and visible national parks and wildlife refuges are found in coastal areas.

However, these resources, as well as our ability to use them wisely and sustainably are at risk.

- Daily, over 2.8 billion gallons of industrial waste water are discharged to ocean waters with chemicals that can be toxic in minute concentrations. Some of these chemicals potentially increase the risk of cancer and reproduction disruption in marine resources and humans.

- Offshore oil and gas development moratoria have been imposed because existing scientific information does not effectively address environmental concerns.

- Increasing nutrients promote algal growth that can kill sea grasses, overgrow corals, deplete oxygen, and promote harmful algal blooms (HABs). Over 50% of our estuarine waters have seriously low oxygen and HABs that present serious health risks to fish, shellfish, and humans in every state.

- Exotic species and changes in freshwater inputs are producing unprecedented changes in species composition and loss of biodiversity.

- Since 1988, an estimated 23,000 coastal and Great Lakes beach closings and advisories were required to protect human health.

Habitat losses and beach erosion are drastically reducing productivity. All 30 states are experiencing shoreline erosion. Wetland losses in Louisiana is as much as 100 square km/yr. About 10% of the world's coral reef are damaged; a further 50% are threatened.

In addition to these concerns about natural resources at risk, there are also growing opportunities for more efficient, effective, and safe use of coastal regions for shipping, transport, recreational boating, and other maritime activities.

In the last 50 years, ships have doubled in size and waterborne commerce has tripled. Today over 98% of all cargo by weight passes through U.S. ports and harbors and safe navigation is becoming increasingly demanding. Half of this commercial cargo is hazardous material which poses a considerable risk to the Nation's coastal environment every hour of every day.

II. TOWARDS SUSTAINABLE DEVELOPMENT, ADAPTIVE MANAGEMENT, AND REAL-TIME OPERATIONS - THE NEED FOR INTEGRATED COASTAL MONITORING

Safeguarding natural resources from these risks requires integrating research and management within an integrated assessment framework -- a framework that documents the status and trend in environmental conditions, evaluates the causes and consequences of those changes, and analyzes the environmental, social and economic impacts of alternatives policies for dealing with those changes. At the same time, ensuring efficient and safe use of the coasts for shipping, transportation, and recreation requires a similar assessment framework, *albeit* one that operates in real time. The primary impediment to progress for both cases is the lack of a nationally consistent, regionally relevant, integrated coastal monitoring and observation system. Output from such a system, would not only make these assessments and real-time operations possible, but also feed research and development efforts and identify emerging issues.

Given the importance of the coastal region to the nation's economy and well-being, and the high potential for human use and natural events to adversely impact the resources and ecosystems of these areas, it is shocking to realize that so little is known about the status and trends in critical environmental variables in coastal regions. Besides programs for coastal weather, water levels, commercial fisheries, and toxic contaminants, there exist **NO NATIONALLY CONSISTENT, COMPREHENSIVE MONITORING PROGRAMS** to provide the information necessary for effective management of coastal systems.

This serious shortcoming in the Nation's environmental program has been recognized and highlighted in recent analyses from government, academia, the environmental community, and industry. For example, in a recent effort to develop a ***Report on the Status of the Nation's Ecosystems*** [1], a group representing all four of those communities reported that we have:

> ... no national monitoring or consistent reporting processes for beach closures, even though thousands of closures occur each year;
>
> ... no national monitoring of conditions leading to coastal eutrophication, even though half of our estuaries have oxygen depletion problems;
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> ... no national monitoring program on the frequency or extent of HABs, fish disease, or pathogens, even though every state is effected and millions of dollars are lost each year;
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> ... no systematic effort to quantify even the areal extent and fragmentation of salt marshes, sea grasses, coral reefs and other important habitats for economically and ecologically important species, even though there are legislated mandates to protect and restore them; and
>
> ... no systematic programs to monitor the loss of species, changes in species mix, or rates of invasions by exotic species, even though we know that these are existing and growing serious threats to our ecosystems and economy.

This difficulty in conducting analyses at national and regional scales, due to lack of nationally consistent monitoring and observing systems, is also hampering efforts to assess potential impacts of climate on coastal systems. The coastal and marine analysis for the ***National Assessment of***

[1]This is an effort funded by government, industry, and foundations, is bringing together representatives from Federal and State government, academia, industry, and the environmental community, through the Heinz Center for Science, Environment, and Economics, to develop a prototype report on the status of our Nation's ecosystems. The first pilot focused on measures of ecosystem goods and services from agriculture, forests, and coasts and ocean sectors. The measures for the coasts and ocean sector were based primarily on anecdotal information or example from specific places because of a lack of nationally consistent monitoring programs.

Potential Impacts of Climate Variability and Change[2] has had to rely primarily on site-specific case studies in its analysis because nationally-consistent trend (and forecast) data are not available for many key properties, such as temperature, salinity, current patterns, habitat extent, and biological community structure.

Similar problems confront the agencies responsible for implementing new legislation calling for ***National Assessments of Harmful Algal Blooms and Hypoxia***[3]**.** These national assessments must rely on sparse, site-specific data and expert judgement to even document the status of the problem; it is not possible to document trends. While sufficient data were available to do a thorough retrospective analysis for the specific Gulf of Mexico/Mississippi River study, that was also called for in the legislation, such an analysis could not be repeated 5 years from now because most of the monitoring system has been shut down, or is in danger of being shut down.

This need for improved integration of coastal and ocean observing systems has also been identified by the Congress. In response to a Congressional request[4], the ***National Ocean Partnership Program*** (NOPP) has prepared a report outlining the needs and strategies for both basin-scale and coastal monitoring and observation systems. This report finds that the "scarcity of observations on coastal ecosystems of sufficient duration, spatial extent, and resolution ... are major impediments to the development of a predictive understanding of environmental variability in coastal waters. There is a clear need to design and implement an integrated coastal ocean observing system that addresses both the impacts of the environment on man's activities, and of man's activities on the

[2]As part of the U.S. Government's preparation for the 2000 IPCC Climate Assessment and other "post-Kyoto" efforts, regional and sectoral teams of academic and government scientists are developing a National Assessment of Potential Impacts of Climate Variability and Change under the US Global Change Research Program. In addition to about 20 regional efforts, four primary sectors have been asked to provide integrating assessments: Agriculture, Water Resources, Human Health, and Coastal and Marine.

[3]The Harmful Algal Bloom and Hypoxia Research and Control Act of 1998 (PL 105-383)calls for National Assessments of the causes, consequences, and actions to prevent and control HABs and hypoxia in coastal waters. It also calls for a specific integrated assessment of the causes and consequences of hypoxia in the Gulf of Mexico and an action plan for remediation, based on that assessment.

[4]Congressmen Saxton and Weldon called upon the National Ocean Research Leadership Council of the National Ocean Partnership Program to "propose a plan to achieve a truly integrated ocean observing system". In response, NOPP convened an academic-government team to prepare a first-response report titled, " Toward a U.S. Plan for an Integrated, Sustained Ocean Observing System." A second report, focused on specific needs and implementation, is being prepared by NOPP's Advisory Panel for delivery to the Congress later this year.

environment and links observation, synthesis and applications in more effective ways."

The need for improving coastal research and monitoring is highlighted in the ***President's Clean Water Action Plan***[5]. Specifically, the Federal agencies have been charged with developing multi-agency plans for coordinated monitoring of the health of U.S. coastal waters and for research to assess the causes and means of dealing with the identified problems.

The Administration's guidance for FY 2001 interagency research and development priorities highlights efforts within the White House Committee on Environment and Natural Resources initiative on ***Integrated Science for Ecosystem Challenges***[6]. This effort to "develop the knowledge base, information infrastructure, and modeling framework to help resource managers predict/assess environmental and economic impacts of stress on vulnerable ecosystems" depends fundamentally on monitoring and observation systems. The ISEC strategy identifies several serious impediments to delivering the integrated science needed to sustain the Nation's ecosystems, and emphasizes the need to bring together social and ecosystems data to produce information and tools needed for effective ecosystem management.

Finally, these needs are not new. This call for an improved coastal observation system, as part of an integrated, interagency coastal ocean science strategy was described in a National Science and Technology Council report, ***Setting a New Course for Coastal Ocean Science***[7]**.** That study recommended that "Effective prediction, assessment, policy, and management are built on

[5]The Clean Water Action Plan, an interagency, intergovernmental effort, charts a course toward fulfilling the original goal of the Clean Water Act - "feasible and swimmable waters for all Americans". While the overall plan includes freshwater, coastal, and marine waters, it calls special attention to coastal research and monitoring needs.

[6]The April 22, 1999 memorandum from the President's Science Advisor and the Director of OMB to Department and Agency Heads outlines the science and technology priorities for FY 2001. The Ecosystem priority supports the efforts of the CENR Subcommittee on Ecological System to develop a comprehensive approach to monitoring, understanding, and assessing ecosystem change and vulnerability to assist those with stewardship responsibility. The emphasis is on impacts from invasive species, land and water pollution, changes in weather and climate, and land and resource use.

[7]This report was developed in the early 1990s in response to a clear need to focus on the coastal ocean. Increasing coastal environmental concerns, controversial fisheries and mineral resource issues, and an increasing emphasis on preparing for coastal, as opposed to basin-scale, international conflict brought together fundamental and applied science agencies to develop a new framework and strategy for U.S. coastal ocean science.

accurate, timely, and appropriate observations and monitoring programs. The output from some observation systems would feed directly into decision making processes, others would support real-time forecasting and analysis capabilities, and still others must be combined with other data sets to form critical assessments of environmental risk. A hierarchy of observation systems would supply appropriate information in real time as seasonal and annual summaries, and as multi-year summaries. The spatial requirements of the observation systems include both regional and national scales."

A National Research Council report on ***Priorities for Coastal Ecosystem Science*** provides a series of recommendations that underscore these needs and provide a path toward a solution. These include:

> ... measure diffuse inputs, particularly of nutrients and toxic chemicals, entering the coastal zone from rivers and the atmosphere;
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> ... develop indicators of biological status and process that can be used more effectively than existing indicators for ecosystem monitoring;
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> ... deploy improved *in situ* and remote sensing systems to allow monitoring of physical, chemical, and biological processes spanning a wide range of spatial and temporal scales;
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> ... link regional and national monitoring to improve the comparability and utility of local, regional, and national monitoring programs; and
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> ... improve monitoring management systems by designing monitoring that is appropriate to the problems being addressed and integrated more fully with management decision-making, research, and modeling[8].

III. A DESIGN FOR COASTAL MONITORING

THE GOAL

For the past several years, the academic, federal, state, and private sector scientists have been

[8]This study was commissioned by Federal agencies as part of its development of science strategies under the National Science and Technology Council. This study, combined with the academic-based ***Freshwater Imperative***, served as foundations for the CENR Water Resources, ***Coastal and Marine Science Strategy*** and its more recent ***Integrated Challenges for Ecological Systems***.

working toward new approaches to monitor physical, chemical, biological, and ecological conditions of coastal waters, bays, estuaries, and the Great Lakes. The efforts appear to converge on a common goal to:

> ... provide a national capability to measure, understand, analyze, and forecast natural and human-induced environmental change that effects coastal economies, public safety, and the sustained production of ecological goods and services.

Achieving this goal will increase the quality and timeliness of Federal actions, assist state and local governmental decisions, aid in private-sector development, and enhance environmental information for national defense. The capability to predict the impact of the growing coastal population will enhance efforts to mitigate and reverse environmental degradation while maximizing economic benefits for the Nation. These capabilities are necessary to achieve the responsible stewardship and sustainable use of the coastal ocean environment.

Insert the 3-tier pyramid graphic here showing Tier I at the top, Tier II in the middle, and Tier III at the base.

A FRAMEWORK TO ADDRESS MULTIPLE TIME AND SPACE SCALES

The design for coastal monitoring, outlined below, has more in common with terrestrial systems than it has with open ocean systems. This is due, in large part, to the close connection between land and water and to the importance of horizontal physical fluxes (i.e., fluxes between land and estuary and between coastal ocean and open ocean) as opposed to vertical fluxes (as in exchange between the surface and deep ocean). This is not to say that vertical fluxes are not important in coastal regions; but that the terrestrial model captures better both the vertically and horizontally important fluxes. For this reason, this effort uses the three-tiered approach adopted by CENR Framework for Environmental Monitoring[9].

This three-tiered approach can be represented as a pyramid that incorporates broad-scale "census"

[9]This 3-tiered framework has been proposed in a number of fora and adopted by the CENR as the most relevant structure for building and integrating environmental monitoring efforts across systems, scales, and institutions.

of fundamental properties at its base (Tier I), issue- or resource-specific surveys and observations in the middle (Tier II), and intensive index sites for monitoring and research at higher resolution time and space scales at the top (Tier III). The design's concept is that interaction among tiers provides the most effective and efficient way to identify emerging issues, observe the natural environmental dynamics (Tier I), track the status of trends of known issues and stresses (Tier II), and develop the understanding needed to forecast subsequent change (Tier III). These tiers and their interactions will be detailed below.

Tier 1 measurements are generally taken at fairly coarse, synoptic spatial scales, except for those that can be remotely sensed from space. They are national in coverage and fall generally into one of two classes:

1. Properties that provide measures of ecosystem response to stress, such as estimates of the abundance of plant and animal species, community structure, distribution of important habitats (e.g., salt marshes, sea grasses, coral reefs, kelp forests), and algal biomass and productivity (e.g. via remote sensing). Significant changes in these properties, outside their natural variations, indicate response to anthropogenic stress and provide early warning for coastal managers and direction for efforts in Tier II.

2) Properties required to interpret natural temporal and spatial variability in the measures described in (1), such as the three-dimensional structure of currents, water levels, temperature, salinity, and the mesoscale atmospheric processes that drive them. These physical observations not only provide context for variations in ecological properties, but they also provide driving variables and boundary conditions for physical forecast models used for both ecological analysis and for navigation support services.

Most measurements in (2) can be automated on ocean buoys. Estimation of algal biomass, productivity, and shallow-water habitats can also be automated and run operationally via aircraft and satellite remote sensing protocols. However, species abundance, community structure, and other measures of environmental health must still be conducted through field sampling and taxonomic laboratory analysis. Remote sensing also provides excellent coarse-scale 2-dimensional coverage of surface currents, temperature, sea level, coastal morphology and other physical properties.

Insert map of East Coast showing EEZ as Tier I, the Chesapeake Bay watershed, estuary, and near coast as Tier II, and small area between Choptank and Patuxent (including sub-watersheds), as Tier III

Tier II measurements are generally taken at higher

spatial resolution but only in regions identified from impacts found in Tier I surveys, from needs articulated by regional, state, and local resource managers, and/or to support specific navigational interests. The following two examples illustrate how Tier II efforts could emerge:

> If Tier I results showed stressed communities and low oxygen levels in a particular estuary or coastal region, a Tier II regional monitoring program could be established. In addition to Tier I properties, this effort would measure relevant environmental drivers, such as nutrient concentrations, river loads, atmospheric loads, and coastal land use, along with higher-resolution measurements of the physical properties that shape the regional environment.
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> If regional maritime interests require improved navigation services, such as access to higher-resolution sea state conditions and forecasts, a Tier II regional observation and forecast program would be developed based on user needs, augmentation of existing atmospheric and oceanic observing systems, and use of emerging technologies.

The primary purpose of Tier II monitoring is to collect data on suspected drivers and impacts to better address resource stewardship and operational needs. Tier II is also conducted at the right scale to help integrate state and Federal regional monitoring programs in the national context provided in Tier I. However, Tier II monitoring alone will not be sufficient for understanding relationships well enough to develop predictive capabilities. Tier III moves in that direction.

Tier III measurements are the most spatially and temporally intensive, but they are taken in only 20-30 smaller sites in the coastal region. Measurement suites typically include all the properties from Tiers I and II, but also include a wide range of additional measures needed to develop a predictive understanding among drivers and response variables. For example, these sites might also include measurements of ecological process rates (e.g., production, consumption, sedimentation, respiration, biogeochemical transformation) and other input variables (e.g., solar radiation, soil chemistry, sediment transport, material flows), all guided by models that integrate physical and ecological processes.

The data and knowledge obtained at these sites aid in interpreting Tier I and II results and link process research with long-term measurements of environmental driving variables to develop cause-effect linkages and predictive models relating stresses and ecosystem responses for issues of concern to society.

INTEGRATING PHYSICS AND ECOLOGY

While the terrestrial model is appropriate for integrating across coastal time and space scales, it is not as good for integrating physics and ecology because, as opposed to terrestrial systems, coastal

ecosystems are fundamentally fluid. The role of physical processes (e.g., atmospheric and ocean circulation, waves, storm surges) in distributing plants, animals, and chemicals is so critical to the functioning of these systems that its measurement often has a predominant role in the design of monitoring, research, and management efforts. This important physical/ecological integration must occur in each Tier described below and will be accomplished through building upon existing capabilities to develop national and regionally-tailored physical observing systems with chemical and biological measurements at appropriate scales. (It is important to note that, while the desired end-point is to have integrated and automated sensors for all properties, that is possible now for only a few chemical and biological properties.) Biological, chemical, and physical measurements will ultimately be integrated through data assimilation, modeling, and information processing systems designed to improve forecasts of coastal environmental conditions phenomena for coastal regimes ranging from estuaries, bays, and harbors to the edge of the Exclusive Economic Zone.

IV. IMPLEMENTATION

Implementation of a new National Coastal Monitoring Program will require improving connections among existing efforts, adjusting those programs to fill gaps among them, and augmenting funding to fill additional gaps targeted in all three Tiers.

BUILDING ON EXISTING EFFORTS

Implementation will build on existing Federal and, more importably, state and academic efforts. Several Federal agencies engage in and support monitoring and observation programs in response to their individual mandates and missions. States also monitor coastal lands and waters to satisfy their needs and to comply with Federal and state statutes. Academic institutions, particularly the network of marine laboratories, also monitor the environment and often have rich physical and ecological data bases on more local scales. This proposed implementation strategy draws on the strengths of each sector and seeks to integrate those efforts, without interfering with their ability to satisfy their existing mandates.

Federal biological/chemical/ecological monitoring networks. Federal agencies also support several national monitoring efforts designed to provide chemical and biological information related to coastal environmental health. For example:

- NOAA's national status and trends (NS&T) program monitors the levels and associated effects of toxic contaminants on a biennial basis at about 200 locations around the U.S. coasts.

- EPA's 305 program provides support for state monitoring efforts to assess the condition of their coastal waters and to determine the suitability of these waters to sustain beneficial uses.

- The USGS/USDA/NOAA/EPA national atmospheric deposition program monitors precipitation chemistry on a weekly basis at about 190 sites around the U.S. to characterize the composition of this precipitation and to determine the spatial distribution and temporal trends in composition.

- The USGS Biomonitoring of Environmental Status and Trends Program (BEST) contributes to periodically characterizing chemical stressors in coastal habitat and has undertaken a retrospective analysis of contaminant exposure and effects on terrestrial vertebrates in coastal habitats. In addition, USGS and its partners coordinate and conduct periodic surveys of avian species utilizing coastal habitats.

- NOAA's National Estuaries Research Reserves monitor water temperature, conductivity, pH, dissolved oxygen, turbidity, local wind speed and direction, air temperature, relative humidity, rainfall, barometric pressure, and photosynthetically active radiation in each of their 21 Reserves.

- The coastal component of EPA's Environmental Monitoring and Assessment Program periodically measures indicators of ecosystem health and of the stressors affecting ecological health in various U.S. coastal regions.

- NSF's Long-Term Ecological Research (LTER) supports investigations of whole ecosystems and their component organisms and processes at sites that represent major biomes. Projects are multidisciplinary and actively encourage collaborative research with non-ecological investigators.

- The NOAA/EPA/NASA coastal intensive site network (CISNet) pilot study is testing a network of 11 intensive monitoring sites around the coastal U.S. where a series of indicator measurements are obtained to track changes in major environmental stressors and to relate these changes to observed effects on the structure and function of the ecosystem.

- NOAA's Coastal Change Analysis Program (C-CAP) classifies types of land cover, analyzes and monitors changes in coastal submerged habitats, wetland habitats, and adjacent uplands using remote sensing techniques (satellite imagery and aerial photography) in selected coastal regions.

Each of these Federal programs was established independently, some decades ago, and they have continued to serve their original missions. What is needed are ways to enhance their integration and coordination both among these Federal efforts and with similar suites of state and academic efforts.

Federal physical observing networks and remote sensing. The Federal government presently maintains operational observing systems and provides real time information and forecasts of oceanic and atmospheric conditions for users in the private sector; local, state, and federal agencies; and the public sector. For example:

- Coastal weather observational systems, including Doppler radars, coastal ocean buoys, and coastal weather stations, provide sustained measurements of atmospheric conditions which impact coastal ecosystems, including rainfall, winds, aid temperature.

- The USGS stream flow gaging program consists of a national network of stations equipped with real-time telemetry. These gages are integral components of reservoir operations, river-forecasts, and flood-warning systems.

- A coarse national grid of tide and water level gages provides information water levels in bays, estuaries, and along the open coast at very fine temporal scales.

- Physical Oceanographic Real-Time Systems (PORTS) located at high traffic port and harbor entrances around the country provide high resolution water level and current information to enhance the safety and efficiency of maritime commerce.

- NSF's LTERs' long-term physical measurements complement the biological and chemical programs to ensure interdisciplinary approaches to complex ecosystem dynamics.

- A regionally-based satellite system, CoastWatch, provides large-scale sea surface temperature and ocean color information which enhances resource management activities of local, state, and federal agencies and for the recreational and commercial fishing communities.

- NOAA/USGS/NASA mapping of the coasts using new laser (Lidar), acoustic, and photographic technology provides a baseline of coastal morphology and geology.

Such systems have proven valuable in serving as the foundation for an expanded and more comprehensive suite of regional efforts. Improvements in such observation networks will advance

the skill in forecasting ocean conditions to address the array of ecologically-based problems facing the Nation.

PROGRAM INTEGRATION, ENHANCEMENT, AND NEW CAPABILITIES

In the following paragraphs, integration efforts and program enhancements that are required to implement this more effective, efficient, and productive national program are outlined. While additional actions could be taken, the ones listed here are the key ones for making significant progress in the near term.

Tier I. Although innovative state and university partnerships are emerging (particularly for cost-effective ways to install and maintain local observation stations and labor-intensive, high-skill tasks of species identification and enumeration) programs carried out in this tier are primarily conducted and coordinated by the Federal agencies. The following efforts would solidify the Tier I program:

Integrate Coastal EMAP and NS&T programs and add species. Develop a joint operating agreement between NOAA and EPA to implement the NS&T and coastal EMAP efforts as a single program. These two programs have complimentary missions and approaches and this joint operating agreement will outline roles and responsibilities, common protocols and standards, and data exchange, management, and reporting methods. For sampling locations in the combined NS&T/EMAP program at Tier I scales, add efforts to sample and enumerate pelagic and benthic species composition. Collaborate with USGS BEST program in developing operational capabilities for biomarkers and bioindicators.

- Enhance and expand remote sensing efforts (e.g., CoastWatch, C-CAP, ARC, MRLC) to provide operational ocean color, turbidity, and SST products; as well as coastal land and habitat coverage change.

- Increase the density of the coastal buoy and shore-based meteorological and water level observing system network and add temperature, salinity, and available chemical, and biological sensors.

Tier II. Efforts within this tier require a more fully-developed and integrated partnership among Federal, state, and academic programs. A key emphasis for these regional programs is to add value to existing State, Federal, and academic monitoring efforts by augmenting existing programs and by providing consistent protocols and standards for data exchange, system comparisons, and regional and national synthesis.

- Expand the capabilities of the USGS to estimate riverine contaminant loads by operating additional stations for sampling water quality and measuring water quantity in coastal areas, as well as in the Mississippi River basin. Provide additional support for further development of computer models to relate land-based activities to the contaminant loads.

- Expand the NOAA/EPA air deposition network in areas where regional programs develop and for properties required by those regions.

- The combined NS&T/EMAP program will support a series of regional estuarine, Great Lakes, and coastal monitoring efforts. These regional efforts will be established through areas identified through Tier I analysis or as areas nominated by the governors of a proposed region, with a particular emphasis on regions in or bordering National Estuaries Research Reserves, National Marine Sanctuaries, and National Estuary Programs.

  Proposals for these regional efforts will be solicited nationally; subject to peer-review for relevance, capabilities, and adherence to nationally-developed protocols, standards, and core parameter suites; and designed by representatives from appropriate Federal, state, and academic institutions in the region. The proposals will describe a coordinated program tailored to the needs of that region, but consistent with the national protocols; include at least one Tier III intensive site; describe how the proposed activities of each participant augment, and are integrated with, ongoing efforts of the participating institutions; and estimate costs for the overall activity, and what part of these costs will be available as matching funds from the ongoing and expanded programs of the participants.

  Requests for Federal funding to implement unfunded parts of this program may be submitted for costs not to exceed the level funded by the non-Federal participants (i.e. 50% non-Federal match). Upon review and acceptance of the proposal, NOAA and EPA will fund the regional group to implement the plan as part of the national network of regional programs.

Tier III. The NSF Long Term Ecological Research (LTER) program has all of the characteristics of Tier III, and there has been a recent call for proposals to expand the number of coastal LTER sites. EPA, NOAA, and NASA have also supported CISNet, a set of 3-year intensive ecological monitoring pilot sites.

- As the CISNet pilots wind down, combine the NSF, NOAA, EPA, and NASA criteria for long term ecological observations and integrate and expand the coastal LTER network.

Special consideration is needed to support all three tiers:

 # Training new taxonomists (THIS NEEDS TO BE FLESHED OUT BY NSF AND SI). While recent and expected new breakthroughs in sensor technology will help automate chemical and some biological measurements, tracking the relative abundance and mixtures of native and invasive species will continue to rely on highly-trained human resources - the taxonomists. Unfortunately, this cadre of experts is diminishing. Efforts identified in all three Tiers to enumerate species should provide motivation for training and employing new taxonomists.

V. BENEFITS

The NCMP will provide the data and information needed to:

Document the status and trends in the condition of U.S. coastal environments.

Characterize and assess problematic conditions in U.S. coastal environments including
- -- beach closures and related pathogenic indicators;
- -- eutrophication and its symptoms such as anoxia and hypoxia;
- -- harmful algal blooms;
- -- disease conditions in fish and other organisms;
- -- toxic contaminants and their effects
- -- losses of major habitat types such as coral reefs, seagrasses, mangroves, and salt marshes;
- -- introduction of exotic invasive species and their spread; and
- -- losses in biodiversity.

Support real-time forecasting and analysis for coastal natural disaster risk assessment and navigational support services.

Design and implement environmental regulation, control, mitigation, and restoration projects and programs.

Assess the success of regulatory and other management actions taken to preserve and enhance coastal environmental quality.

VI. COORDINATION

A formal coordination and advisory structure will be established in three components:

1. An interagency coordination committee responsible for oversight of the overall program. This could be formalized under the CENR Subcommittee on Ecological Science, the Intergovernmental Task Force on Monitoring, or some other structure that can transcend short term changes in management or program policy.

2. A User Advisory Committee composed of representatives from federal, state, and local government, academia, the environmental community, and the private sector resource managers and operations to ensure the products and services of the program are relevant and stay on track.

3 A Technical Advisory Committee composed of representatives from federal, state, and local government; academia; the environmental community, and the private sector science agencies to ensure the development and implementation of the program uses the best available scientific methods and technologies.